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(54) Lighting system for cycles

(57) Cycle lights 16 and 17 are en-  
ergised by a battery 15 when the  
output from a generator 10 is low.  
Switchover circuitry, 11 to 14, may

be responsive to the frequency of the generator output. Alternatively, switching may be in dependence on the generator output voltage, a series diode (28, Fig. 3, not shown) connecting the battery (29) to the lights 16 and 17. The generator may charge the battery via a resistor (27) in parallel with the diode (29). The generator output may be limited by a Zener diode 24. The battery and control circuitry can be located in a housing (40, Fig. 4, not shown) which clips to the cycle frame and has a multiple connector for connection to the generator and lights. This connector may also be used for charging the battery from a mains transformer.

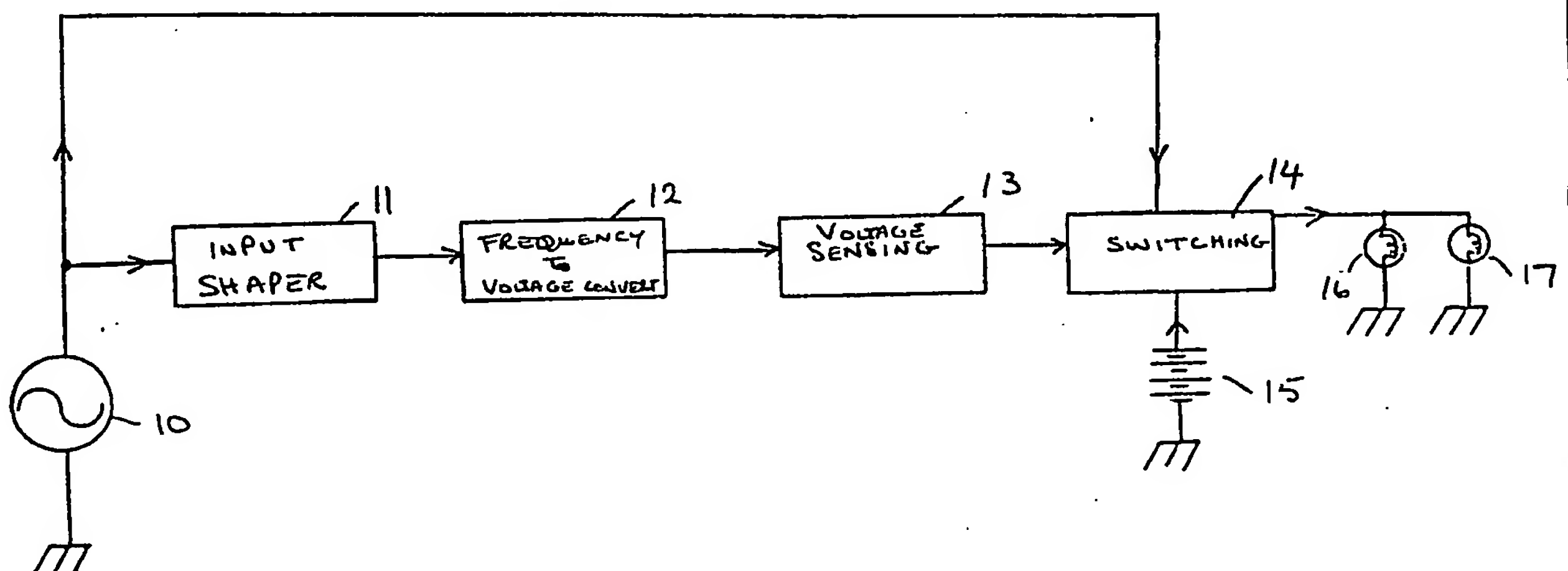


Fig 1

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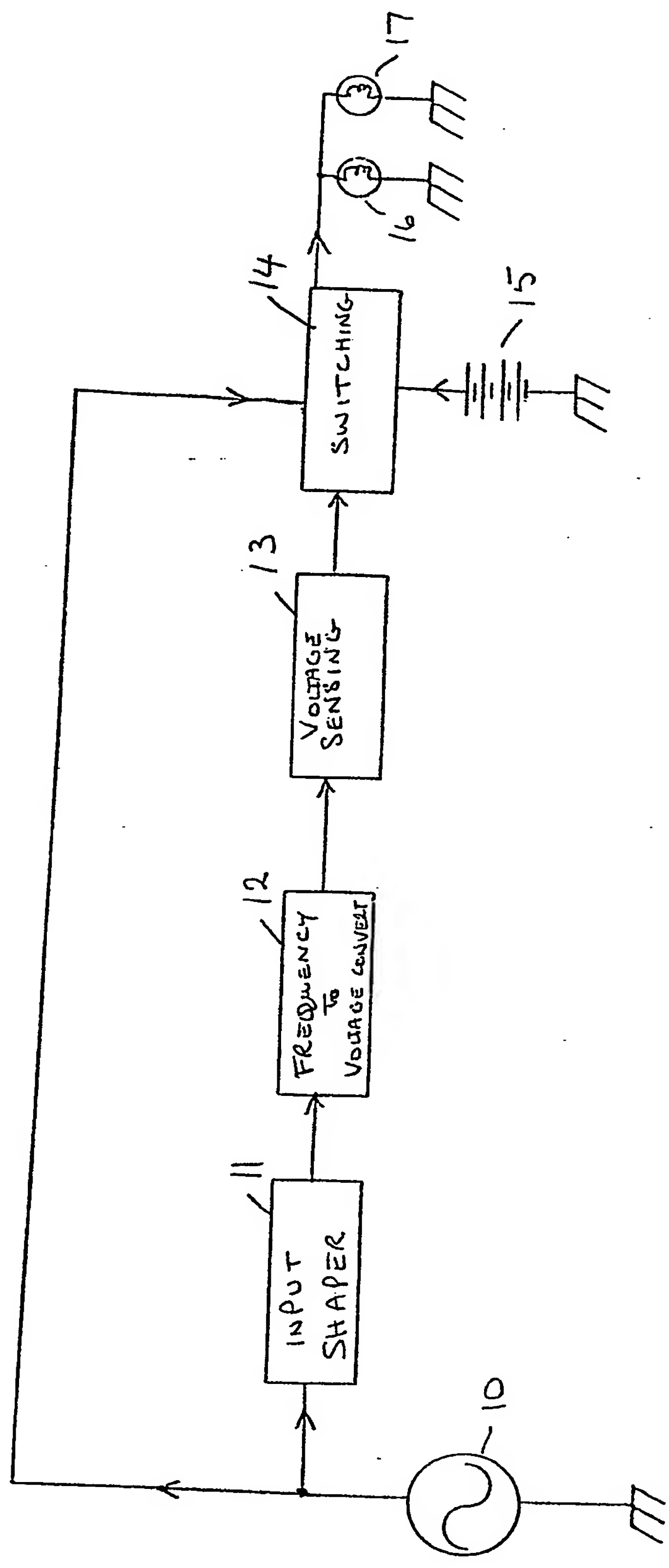


Fig 1

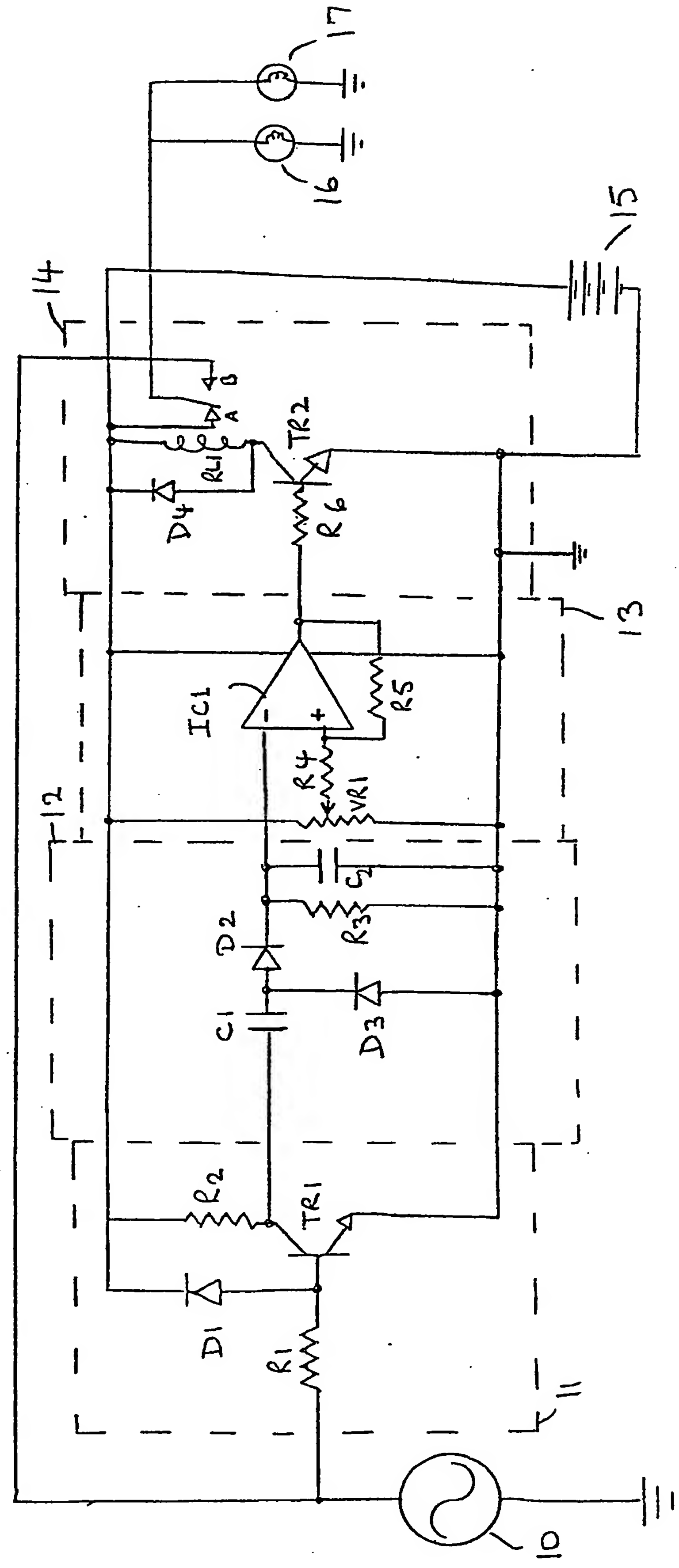
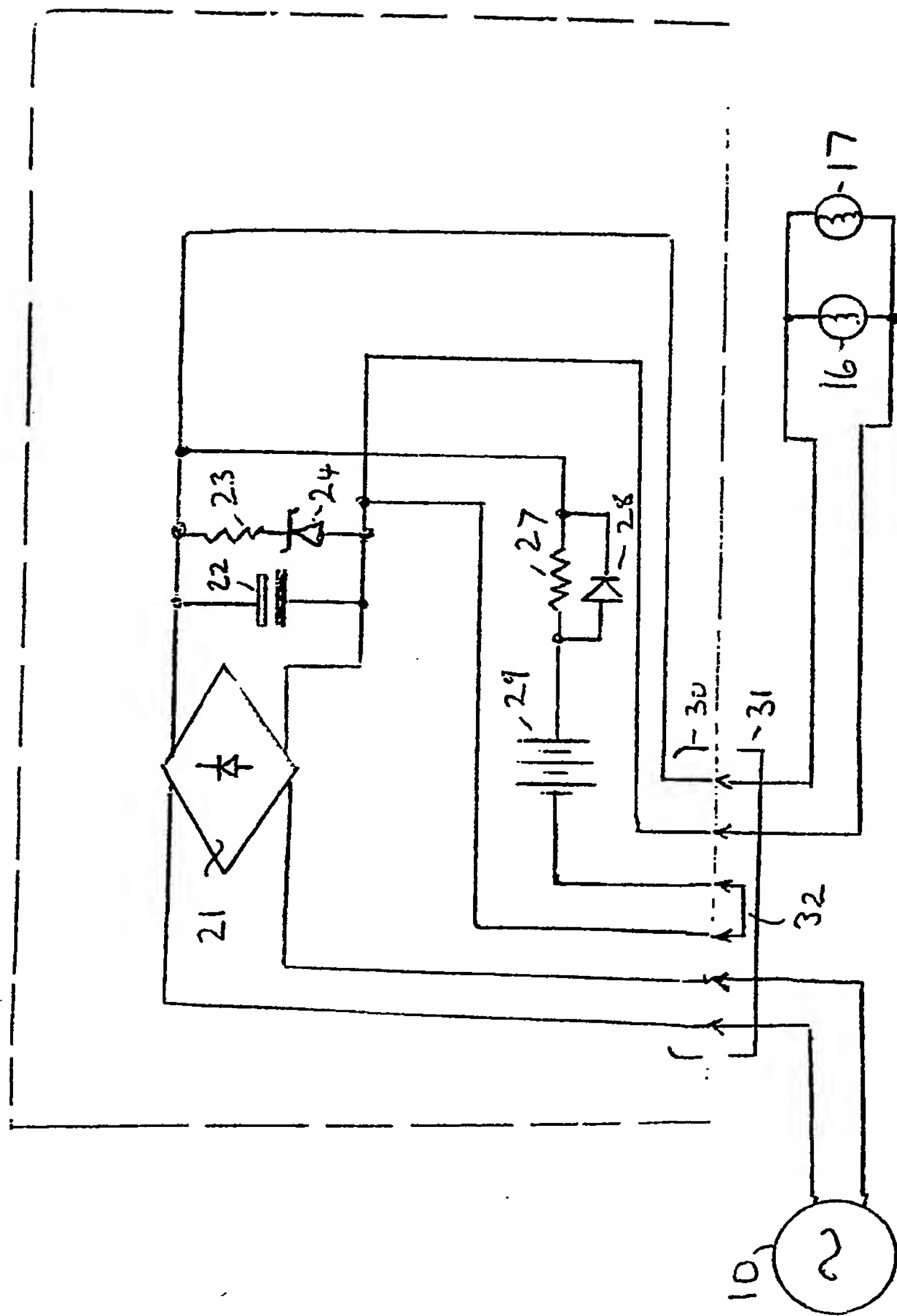


Fig 2



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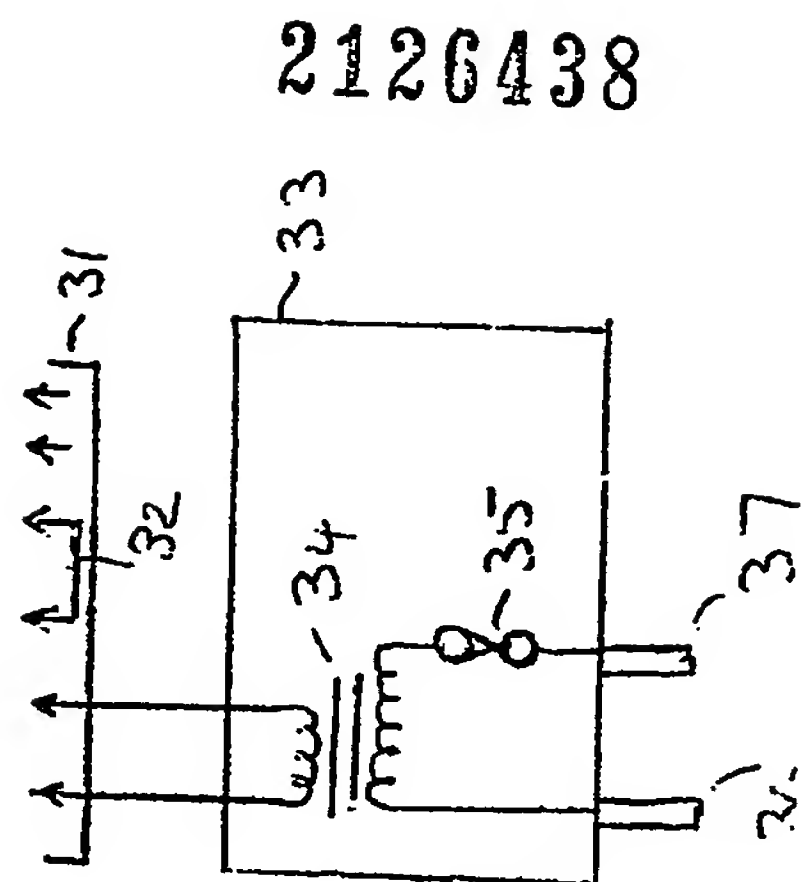


Fig 3.

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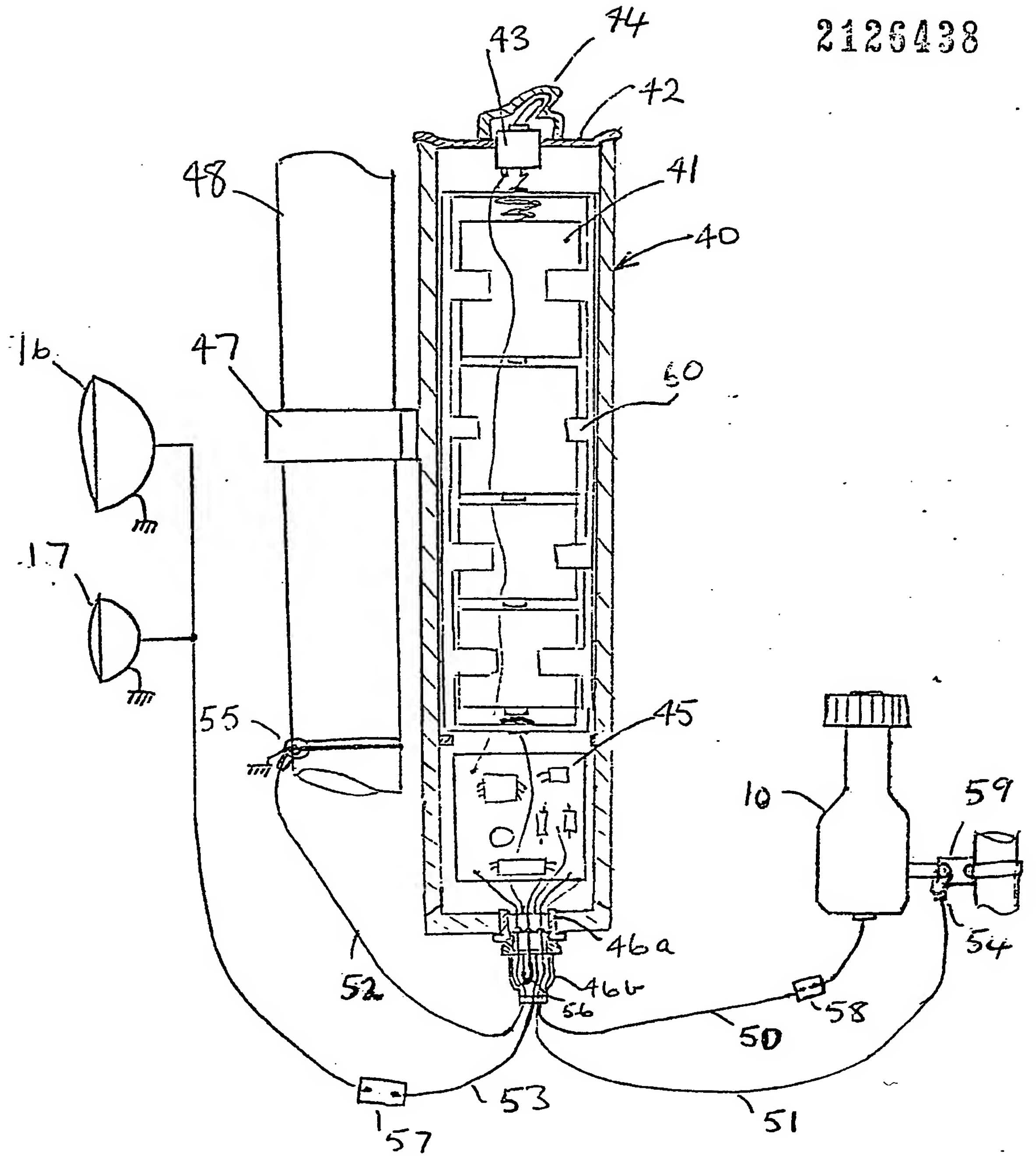


Fig 4.

## SPECIFICATION

### Lighting system for cycles

5 The invention relates to a lighting system for cycles. With dynamo lighting systems, when the bike stops moving the lights are extinguished. The present invention is directed to improving this situation.

10 According to the invention there is provided a lighting system for cycles including a dynamo, a dynamo output sensing circuit and a switching arrangement for connecting the dynamo or an auxiliary power source to the  
15 lights in dependence on the output sensing circuit.

Further according to the invention there is provided an add on lighting system for existing dynamo cycle circuits including a housing  
20 adapted to be mounted on said cycle, a battery holder within said housing, circuit means within said housing for connecting the battery, when fitted, to the existing lights when the dynamo output is low, and means  
25 for coupling the modified dynamo connections to and from the housing.

The invention will now be described with reference to the accompanying drawings in which:

30 *Figure 1* shows a first embodiment of the invention,

*Figure 2* shows an arrangement for producing this embodiment,

35 *Figure 3* shows an alternative embodiment, and

*Figure 4* shows an arrangement incorporating such systems.

In order to produce an automatic system, consideration could be given to an arrangement which monitors the voltage output of the dynamo and switches in the battery via a relay when the dynamo voltage falls below a certain level and switches out the battery when the voltage increases above a certain  
45 level whereby the dynamo again takes over the power generation for the lights. The problem with such an arrangement is that because of the relatively high loading of the lights, there is a very large change in the output  
50 voltage from the dynamo when it is changed from the connected to disconnected positions. Thus the typical loaded voltage of 6 volts RMS when the lamps are connected, rises to a voltage of the order of 20 volts when they  
55 are disconnected. This results in a situation where, as the bicycle slows down, the voltage falls and at a certain point (say 3 volts) the relay is switched over to disconnect the dynamo and connect the battery. This results in  
60 an immediate rise in the dynamo voltage, so that the voltage now sensed is high enough to cause the relay to switch again, which voltage then falls and so on. Because of this large voltage swing it is very difficult to prevent the  
65 relay continually oscillating between loaded

and unloaded condition of the dynamo at certain wheel speeds.

One way that may be employed to overcome this problem is to use an additional  
70 relay (or relay contacts), such that a 'dummy' load is connected across the dynamo when the lamps are connected to the battery, which load is selected to have a resistance which will give an equivalent drain to that produced by  
75 the lamps.

The resistance required is very low, (e.g. 8  $\Omega$ ), and must have high dissipation capability (e.g. 5 watt). The power dissipated can cause substantial heat to be given off by the resistor. A further disadvantage of using the  
80 dummy resistor, is that the rider is expending energy, merely for dissipation in the dummy load when the battery is driving the lights. This is even more pronounced in that it is at  
85 the lower speeds that the wastage is occurring, which speeds can be encountered when pedalling uphill for example or moving away from rest, situations where the rider's energy is most needed.

90 *Fig. 1* shows a system which overcomes this problem and substantially reduces dynamo drag at slow speeds.

The dynamo 10 is shown connected to an input shaper 11, which converts the generally  
95 sine wave output from the dynamo into pulses. The shaper output is received by converter 12 which transforms these pulses into a substantially d.c. voltage typically proportional to the input frequency. This voltage is passed  
100 to sensing circuit 13, which actuates the switching circuit 14 when the voltage is above (or below) a given level, so that the lamps 16 and 17 can be fed either from the battery 15 or the dynamo 10. By providing a  
105 frequency sensitive configuration, the system is not influenced by any loading of the dynamo. As no 'dummy' load is required, the input shaping circuit 11 can be made to present a high impedance to the dynamo, so  
110 that no wasteful power need be expended by the rider.

An arrangement suitable for producing the *Fig. 1* configuration is shown in *Fig. 2*.

The generally sinusoidal input from dynamo  
115 10 is received by the shaping circuit 11 formed by R1, R2, D1 and TR1. Successive cycles of the a.c. voltage trigger transistor TR1 since the increasing voltage saturates the transistor via R1 and remains conductive till  
120 the voltage falls once again, thus generating pulses at the output of R2 at a rate dependent on the incoming frequency. Diode D1 prevents excessive positive levels of the incoming voltage overloading the transistor, which  
125 could occur in the situation where the dynamo output increases after switchover. Additional diode clamping could be used to deal with negative going portions.

The pulse output from transistor TR1 which  
130 will have a constant amplitude passes to fre-



quency to voltage converter 12 formed in this embodiment by a diode pump configuration C1, D2, D3, and C2. C2 is typically larger than C1, and C2 is charged by C1 in steps at a rate determined by the input frequency. By including a high value resistance discharge path with R3, the voltage at C2 at any given time will relate to the incoming frequency rate. Thus this frequency dependent voltage can be passed to sensing circuit 13 employing a voltage comparator IC1 using an operational amplifier. The output of C2 is connected as shown to the inverting input so that the comparator output will be high when the C2 voltage is below the threshold determined by VR1. Resistors R4, R5 provide switching hysteresis so that switch on is at a different voltage to switch off.

The comparator output is used to switch relay RL1 via R6 and transistor drive TR2. Contact A is shown connected to the moveable central contact which will be the situation where the dynamo output frequency is below the required switchover point. Thus lamps 16 and 17 are powered by the battery 15 which also powers the circuits 11 to 14. When the dynamo frequency is sufficiently high, the voltage C2 will trigger the comparator making its output go low thus turning off transistor TR2 and de-energising the relay so that contact B is now connected to the central contact so that the lamps are powered by the dynamo 10. Making the relay operate in this way ensures that no battery drain is employed to energise the relay during normal bicycling (when the rider is moving at sufficient speed). This keeps consumption normally to operating the circuitry which is typically 1 mA or less. Also if the battery becomes exhausted after considerable use, then the relay falls into a fail-safe condition, where the dynamo is permanently connected to the lamps as if in the standard dynamo arrangement.

As a refinement, a zener diode of selected voltage could be incorporated to cause the circuit to be deactivated when the battery voltage fell below a given value.

The loading of the dynamo when the relay contacts are in the position shown is related to the value of R1 which is typically several thousand ohms so that in the worst case situation, this can be assumed to be the least impedance across the dynamo presented by the circuit so as to be negligible in practice.

Although the diode pump is ideal for producing the controlling voltage dependent on the dynamo frequency, it may be that other configurations could be used for frequency discrimination, employing frequency comparison techniques for example.

In an alternative system, shown in Fig. 3, the problem of switching is overcome by including solid state switching whilst allowing recharging of the batteries to be achieved.

The dynamo is arranged to be isolated from

the lamp circuit by mounting the generator 10 on an insulating base for example or by using plastics fittings.

The dynamo output is rectified by bridge rectifier 21 and is regulated by reservoir capacitor 22 into a substantially d.c. voltage.

The voltage at high speeds is also regulated by resistor 23 and zener diode 24. The d.c. output drives the lamps 16 and 17, isolated from the dynamo generated a.c. output. In addition the battery 29 is charged via resistor 27. This resistor provides a generally constant current path when the bicycle is moving normally. The diode 28 acts as a voltage sensor and only allows the battery to be connected directly to the lamps when the battery voltage is higher than the dynamo derived voltage.

Thus if the batteries are discharged they will not be switched into the lamp circuit but will receive a charge current. With nickel cadmium cells the resistor 27 is sufficiently high to reduce the charge current to a safe level at the various speeds. Typically  $3 \times 0.5$  AH batteries are sufficient to provide lighting because they are only used intermittently and are charged during the journey, so allowing a lightweight and compact system to be provided. These require a typical charge rate of about 50 mA. The zener 24 and resistor 23 are effectively series connected directly across the lamps and only regulate the dynamo output when this would otherwise become excessive, such as may occur when travelling downhill, but normally presents no load or impedance to the dynamo output, by choosing a sufficiently high voltage zener. This tends to prevent blown bulbs and also excessive charge rates are avoided which could reduce the battery operating life.

Should a bulb burn out from normal wear, the regulator again prevents excessive voltages which would occur at lower speeds due to the reduction in lamp loading. Even if the lamps are switched off, the regulator is sufficient to prevent damage, so that the batteries could be charged during the day, by switching of the lamps. Without this regulation the voltage can rise to 2 or 3 times that when the lamps are incorporated.

A plug 31 and socket 30 are provided to allow connection or disconnection of the dynamo and lamps to the unit. A link 32 is used to ensure that no accidental battery drain occurs when the unit is disconnected. A mains charger 33 is provided again with a similar plug 31 and link 32 to allow additional overnight charging for example. Pins 36 and 37 cooperate with the mains socket in normal manner to supply power to the transformer 34 via fuse 35. There is no need to rectify the a.c. output as items 21 and 22 can be used for this purpose.

Incorporating Schottky diodes for the bridge and sensing minimises circuit losses.

The zener regulator could also advantage-

ously be included in the Fig. 2 system. Here however a series diode would also be necessary to prevent unwanted conduction at low voltages as the lights in that system receive an a.c. output.

The system electronics and batteries could be incorporated in a large headlamp housing for example but as the system can be used as an add on to existing systems the arrangement of Fig. 4 is provided for such use.

An elongate housing 40 shown in section, typically tubular in form to follow the cycle shape, includes a portion for holding batteries 41 and a portion for circuit board 45. A seal 42 is provided to close the housing whilst allowing removal to gain access to replace batteries. A switch 43 is provided and carries a neoprene cover 44 to prevent moisture entering in rainy conditions. This switch could be used to switch in the lamps or the batteries into the new configuration. The housing is fixed by means of clip, clamp or tie 47 to frame 48 typically with the switch uppermost to allow the rider to switch on the lights without dismounting. A pair of connectors 46a, 46b provide the means for connecting the dynamo 10 input and the outputs to lights 16 and 17 via cables 50, 51 and 52, 53 respectively. The connector 46b typically can be rapidly disconnected from 46a so that the housing can be removed from the cycle by undoing item clip 47 so that the user can prevent theft if the cycle is left unattended. The unit is small enough to fit into bag or coat pocket.

The board 45 carries the circuit which determines when the battery is used alone to supply the power. The connector carries the link 56 to cause the battery to be connected to the circuit only whilst the connectors are mated. The batteries may be carried on an inner pod 60 as shown.

The unit when incorporating the Fig. 3 system may be coupled to an existing lighting system by isolating the dynamo generator 10 if necessary by means of insulating mounting 59, and the wire 51 can carry a tag 54 for connecting to the generator frame. The wire 52 also carries a tag 55 for bolting to a convenient point on the cycle frame. Connectors 57 and 58 are provided so that the normal existing connections can be cut and incorporated in the modified system.

If the unit incorporates the Fig. 2 arrangement, isolation of the dynamo is not required and only one tagged wire is required to act as a common connection to the frame.

#### CLAIMS

1. A lighting system for cycles including a dynamo, a dynamo output sensing circuit and a switching arrangement for connecting the dynamo or an auxiliary power source to the lights in dependence on the output sensing circuit.

2. A system as claimed in claim 1, including regulating means for regulating the dynamo output prior to receipt by said sensing circuit.

3. A system as claimed in claim 2, wherein said regulating means includes a clamping circuit for producing an output amplitude generally independent of dynamo speed.

4. A system as claimed in claim 1, 2 or 3, wherein said sensing circuit comprises a dynamo output frequency circuit.

5. A system as claimed in claim 4, wherein said circuit includes means for producing a control signal for changing the switching arrangement when the dynamo output frequency exceeds a predetermined level.

6. A system as claimed in claim 5, including an electromechanical relay operable by said control signal.

7. A system as claimed in claim 4, 5 or 6, including a diode pump circuit for producing a voltage proportional to the dynamo frequency.

8. A system as claimed in claim 2, wherein said regulating means includes a diode rectifier and reservoir capacitor.

9. A system as claimed in claim 2 or 9, wherein said regulating means includes a zener regulator.

10. A system as claimed in claim 9, wherein said zener regulator is connected across said lights via a series resistor.

11. A system as claimed in any one of claims 1, 2, 8, 9 or 10, wherein said auxiliary power source comprises a rechargeable battery adapted to be charged via the rectified output of the dynamo.

12. A system as claimed in claim 11, wherein a transformer is provided to provide an auxiliary charging point via the mains supply.

13. A system as claimed in claim 12, wherein the transformer is provided in a housing remote from said diode rectifier.

14. A system as claimed in any preceding claim, including a housing including battery holding means for receiving batteries, a circuit board containing said circuit in said housing, input means for receiving an output from the dynamo, and output means for connecting the system output to the lights.

15. A system as claimed in claim 14, wherein said input and output means include a co-operating connector for allowing rapid disconnection of the unit from the system.

16. A system as claimed in claim 15, wherein control means are provided to remove the battery from the internal circuit on separation of said connector.

17. A system as claimed in claim 14, 15 or 16, including a switch sealed against moisture ingress.

18. A system as claimed in any one of claims 14 to 17, including rapidly demountable means for rapid mounting of said unit to



the cycle.

19. A system as claimed in claim 18, wherein said means comprises a clip or the like.

5 20. A system as claimed in any preceding claim, including means for isolating the dynamo generator from the cycle.

10 21. A system as claimed in any preceding claim, including means for connecting to the cycle frame earth return.

15 22. An add on lighting system for existing dynamo cycle circuits including a housing adapted to be mounted on said cycle, a battery holder within said housing, circuit means within said housing for connecting the battery, when fitted, to the existing lights when the dynamo output is low, and means for coupling the modified dynamo connections to and from the housing.

20 23. A system as claimed in claim 22, including control means for disconnecting the internal battery connection when the unit housing is uncoupled from the modified cycle system to prevent accidental battery drain.

25 24. A system as claimed in claim 22 or 23, including a transformer mounted in a separate housing for charging the batteries.

30 25. A system as claimed in claim 24, wherein a common connector is provided to couple the dynamo or the transformer to charge the batteries.

35 26. A lighting system for cycles including a dynamo, a housing for receiving an auxiliary power source and circuit means for providing power to the lights when the dynamo output is low, means for interconnecting said system and means for affixing said housing to said cycle.

40 27. A lighting system for cycles substantially as described and illustrated in the accompanying drawings.

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